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Does metaverse fidelity matter? Testing the impact of fidelity on consumer responses in virtual retail stores

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ABSTRACT

The future of retailing takes consumers to the metaverse. Yet, how these novel shopping experiences will look and feel remains largely unknown. Experts predict immersive metaverse shopping experiences will help build even deeper connections with customers. We conducted a virtual reality (VR) experiment ($N = 127$) into the effect of metaverse fidelity on consumer responses to shopping (vs. browsing) for groceries in a virtual retail store. Our results suggest that metaverse fidelity has no general effect on consumer responses. However, after browsing the VR supermarket, repeat store visit intentions of male customers were significantly lower in the high (vs. low) fidelity condition, whereas female customers responded positively. This finding suggests fidelity to generate goal-specific responses that are also contingent on customers' gender, underscoring the contextual sensitivity of consumer responses in future metaverse shopping experiences.

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Introduction

The world of retailing is at the verge of a revolution. The fast and inexorable advancement of virtualization technologies, such as virtual reality (VR), augmented reality (AR), and mixed reality (XR) devices, have given consumers access to immersive virtual 'worlds' that are now collectively being referred to and commercialized as the *metaverse* (Hennig-Thurau et al. 2022; Lavoye, Mero, and Tarkiainen 2021). According to experts in the field, the immersiveness of metaverse shopping experiences will supersede the appeal of existing forms of touchpoints in retail, such as brick-and-mortar stores, e-commerce sites, and apps (Wolpert and Roth 2020). McKinsey & Company (2022) estimates the value creation of metaverse businesses to surpass 5 trillion USD by 2030 as venture capital and private-equity investments in metaverse ventures more than quadrupled in 2022 to 120 billion USD, up from 13 billion the previous year.

The above figures underscore that the race for the metaverse is well underway. However, when considering our knowledge about past disruptive technologies, they can come with unwanted or unintended consequences (Frank, Chrysochou, and

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Mitkidis 2022). For example, service robots, introduced in physical retail stores to serve customers at significantly lower costs compared to their human counterparts, came with the unintended consequence of sacrificing customer satisfaction with store experiences leading to less loyal customers (Frank and Otterbring 2023). This issue highlights the need to better understand the impact of the metaverse, especially when and why customers are more or less willing to adopt, interact with, and integrate metaverse shopping in their daily routines.

Creating successful shopping experiences in the metaverse is different from creating them in any physical retail stores because, unlike the real world, the possibilities of creating immersive shopping experiences in the metaverse are *virtually* unlimited. Due to being virtualized, all aspects about the store environment, such as location, layout, lighting, time of day, crowdedness, and assortment (Bonfrer, Chintagunta, and Dhar 2022) as well as retail experiences, such as movement, sounds, haptics, interactions, and interfaces are fully customizable – to the retailers' and customers' liking. In theory, this should translate to metaverse shopping experiences as significantly enhancing the value of retail offerings and strengthening the retailers' connections with their customers (Shankar et al. 2021). Moreover, because metaverse retail stores are readily *shoppable* from the comfort of customers' homes, they promise to turn into a highly versatile customer touchpoint that boosts the overall omnichannel customer experience and increases customer loyalty (Hänninen, Kwan, and Mitronen 2021; Rahman et al. 2022).

Despite these advantages of metaverse retailing, a major factor in customers' responses to these novel shopping experiences is the means by which they are accessed. Major technology companies, including Meta, Microsoft, Apple, and Alphabet, have or are about to enter mass-market production of their own VR devices for customers to access the metaverse (McKinsey & Company, 2022). These devices, like smartphones back in the day, push the boundaries of what is possible in terms of virtualizing the metaverse worlds from iteration to iteration. In the current research, we examine whether and how the fidelity, defined as the degree of conformity between the visual quality and experience in VR to the same phenomena in the real-world (Huang and Klippel 2020), conveyed by all these different devices may affect customers' experiences when shopping or browsing in the metaverse. In the context of the metaverse, fidelity plays a pivotal role, intertwining with immersion and telepresence, as it pertains to the level of realism that is experienced by the user. It involves the degree to which the virtual environment mimics the real world, encompassing visual quality, audio, haptic feedback, and interactivity (Khatami et al., 2020). A high level of metaverse fidelity ensures that the virtual experience closely aligns with a user's expectations and enhances their sense of presence within the digital environment, thereby contributing to a heightened state of immersion and telepresence. This heightened fidelity not only brings realism to the virtual world but also intensifies the feeling of 'being there,' ultimately enriching the user's engagement and interaction with the metaverse. A recent controversy about Meta's newly developed 'Horizon Worlds' social meeting space for the metaverse being low in fidelity has shown that prospective consumers' expectations could be clearly missed in this regard, pointing to metaverse fidelity being a driving factor for their intended future use of such experiences (Liu, Macchiarella, and Vincenzi 2008; Smith 2022). Accordingly, the selection of different VR headsets that can access the metaverse has the potential to affect customers' experience of metaverse fidelity, largely driven by the technical constraints inherent in these

headsets. Accordingly, a systematic investigation of this potentially critical effect of metaverse fidelity on customer responses to metaverse shopping experiences is needed.

The goal of the current study is to contribute to the understanding of the influences on consumers' perception and future engagement with the metaverse by exploring the effect of metaverse fidelity on customers' future store visit intentions in response to shopping or browsing in a virtual metaverse grocery store. In a carefully designed laboratory experiment ($N = 127$), we test the effect of high (vs. low) metaverse fidelity on this outcome by exposing one group of customers to a high fidelity metaverse store visit (using a high-end, tethered VR headset) and another group to a low fidelity version of an otherwise identical store visit (using a popular, mobile VR headset). Moreover, we test the generalizability of this effect for the two most common store visit goals: browsing and shopping in a store. The results from this experiment suggest that high (vs. low) fidelity significantly decreases customers' future store visit intentions after a given store visit but only for male customers and not their female counterparts (who are responding positively to higher fidelity); however, this pattern only applies to browsing but not to shopping in the virtual store. These results point to novel implications for the future of metaverse retailing, as they suggest fidelity to affect customers' store visit intentions in a gender-specific and goal-contingent way.

Theoretical background

Virtual worlds, such as those currently being rediscovered as the *metaverse*, have been subject to consumer research for well over two decades (Hoffman and Novak 1996). Unique about today's metaverse experiences are that they are accessed through hightech VR headsets, with higher display resolution, larger field of view, and better graphic rendering performance than ever before. As such, the degree of conformity between the visual quality and experience of VR better matches the same phenomena in the real-world (Huang and Klippel 2020), breaking down prior barriers to consumer adoption (Laurell et al. 2019). In this regard, some scholars speculate about metaverse fidelity being a determinant of positive customer responses to virtual experiences (Ahn 2022; Giang Barrera and Shah 2023). The findings of Jiang and Benbasat (2007) and Elder and Krishna (2012) imply that high fidelity VR environments will enable consumers to better inspect, for example, products placed in a VR supermarket, with fidelity also improving the VR shopping experience due to a higher degree of immersion (Al-Jundi and Tanbour 2022). Thus, it seems plausible that high fidelity should provide richer information, potentially facilitating consumer decision-making. Indeed, high fidelity VR environments have been shown to provide richer sensory information and lead to better purchase decisions fostering consumer loyalty (Li, Daugherty, and Biocca 2002; Young Kim and Kim 2004).

Prior research, however, finds no link between the visual realism of virtual environments and individuals' object memory performances (Huang and Klippel 2020). This finding is in line with the general notion that vividly presented information rarely carries a greater weight in people's judgment and decision-making compared to less vividly presented information (Blondé & Girandola 2016; Collins et al. 1988; Otterbring, Bhatnagar, and Folwarczny 2022; Taylor & Thompson 1982). Nevertheless, prior studies have not considered fidelity in customers' responses to metaverse retail experiences, and by combining knowledge about the important role of immersion in shopping

experiences, it seems likely that high, as opposed to low, fidelity might lead to more positive customer responses (Petit, Javornik, and Velasco 2022; Wang et al. 2022). Among the theoretically most relevant of such responses are customers' future store visit (repatronage) intentions; that is, customers' intentions to revisit a store in the future (Maxham and Netemeyer 2002; Otterbring and Lu 2018). These future-oriented behavioral intentions are typically the result of customers' overwhelmingly positive experiences with a given retailer (Stein and Ramaseshan 2019), which is why they are expected to increase after customers' experience of a high fidelity metaverse in retail settings.

Despite stereotypical gender roles being on the decline (Otnes and McGrath 2001), the 'selectivity model' (Meyers-Levy 1989; Meyers-Levy and Loken 2015) suggests that females and males have different strategies for information processing. It assumes that females are more likely to detect, elaborate more extensively, and use relatively less accessible and more distally relevant information when, for instance, evaluating products in a shopping context. Hence, female customers may be more prone to responding to metaverse fidelity cues than their male counterparts. This possibility seems plausible in light of research suggesting that females (vs. males) are more comprehensive information processors who respond to more subtle cues when considering product attributes (Darley & Smith 1995). Moreover, gender differences also play a role in the context of consumer repatronage intentions. For example, Noble et al. (2006) found that male customers' loyalty to local merchants was motivated by convenience and information attainment, whereas female customers' loyalty was driven more by desire for browsing, assortment, uniqueness, and social interaction opportunities.

Research focusing on the impact of goal-orientation on consumer behavior has shown that goal-orientation (e.g. shopping vs. browsing) has an impact on aspects such as how consumers process information and behave in shopping contexts (Hwang and Lee 2017). According to Babin et al. (1994), consumers with a goal-oriented shopping motivation are concerned with purchasing products in an efficient and timely manner to achieve their goals with a minimum of effort and irritation. Conversely, consumers with a browsing motivation are likely to consider store visits more as fun and entertaining (Holbrook and Hirschman 1982), which should also be reflected in differences regarding how they process product information and how they experience the retail store environments. Moreover, prior research has demonstrated the ability of promotion and prevention regulatory orientations to moderate a variety of consumer and marketing phenomena (for a review, see Pham and Higgins 2005). Regulatory focus theory (Higgins 1987; Higgins et al. 2001) specifically suggests that individuals are either disposed to seek promotion or prevention goals and to pursue such goals through eager or vigilant means. The findings of McKay-Nesbitt et al. (2013) indicate that, overall, males are more promotion-focused than females, while females are more prevention-focused compared to males when seeking to achieve their goals. Hence, male customers' lower attention to subtle cues in combination with their stronger promotion-focus could potentially make them more prone to prioritize the overall impression of the metaverse . Conversely, female customers may be more strongly driven by their store visit goals and prioritize content such as the information available at a given point in time (Pounders, Rice, and Mabry-Flynn 2017).

Based on the literature delineated above, we hypothesize that the impact of metaverse fidelity on customers' future-oriented store visit intentions should be moderated by consumer gender. More precisely, given the previously documented gender difference regarding regulatory focus and female consumers' more detail-oriented information processing, we expect this link to be stronger for female (vs. male) customers. Formally stated, we hypothesize that:

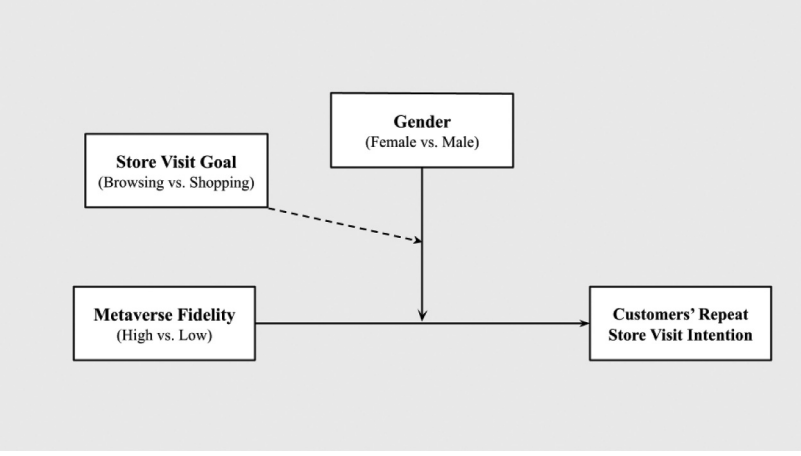

Figure 1. Conceptual model.

H1: The impact of metaverse fidelity on customers' future store visit intentions is moderated by consumer gender, such that female (vs. male) customers respond more favorably toward high (vs. low) metaverse fidelity.

To supplement this main hypothesis, and to test the generality and external validity of the presumed gender difference as a function of metaverse fidelity, we also explore potential differences between the two most common store visit scenarios by means of goals focused either on browsing or shopping. We do so given the value of exploratory research in proposing original theory (Alba 2012; Ares et al. 2023; Golder et al. 2023), considering that exploratory research is clearly under-utilized in marketing, retailing, and consumer research, despite its boundary-breaking potential (MacInnis et al. 2020). The conceptual model is depicted in Figure 1, with the straight lines representing the hypothesized moderating role of consumer gender into the link between metaverse fidelity and customers' future store visit intentions (as per **H1**), and the dotted line reflecting the possibility that this two-way interaction might, in turn, be contingent on customers' store visit goal.

The study of customer responses to metaverse shopping experiences is novel. Our systematic review of the relevant literature, summarized in Table 1, shows that 13 articles present empirical evidence on shopping experiments on fidelity-related responses in which participants were actually using some kind of VR headsets with none of these demonstrating a true VR-to-VR headset comparison. Moreover, no prior research used animated avatars for both customers and staff to facilitate immersiveness of the metaverse for customers' virtual store visits experiences, which is striking, as avatars – virtual representations of human and non-human characters – are a defining feature of the metaverse (Miao et al. 2022).

Table 1. Relevant literature on customer responses to fidelity of virtual reality environments and similar constructs (e.g. realism, visual quality, immersion, presence) in shopping settings.

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
van Herpen et al. (2016)	Virtual reality: Increases the realism of the choice environment compared to lab setups using textual or pictorial stimuli.	$N = 90$ $N = 100$	✓	✓ Physical vs. 2D, Physical vs. 3D "VR" (Computer)	✓		Groceries			• Immersive VR elicits behavior more similar to that in a physical store than to that of a 2D picture based condition for the number of products selected, amount of money spent, and for the selection of products from different areas of the shelf, both vertically and horizontally.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Jang et al. (2019)	Immersive VR: Use of headsets that allow users to enjoy more realistic experiences by completely blocking visibility and synchronizing body movements.	$N = 101$	✓		✓ (Branded)		Sports shoes		✓	• As consumers perceived higher levels of vividness and interactivity, perceived telepresence was higher, leading to higher perceived experiential shopping value and an overall positive influence on approach intentions to a VR store.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Peukert et al. (2019)	Immersion: The degree of isolation from reality (inclusive), the number and magnitude of different sensory channels that are stimulated (extensive), the presentation format in terms of the field-of-view delivered by the medium (surrounding), as well as the extent to which a system is capable of creating naturalistic environments from a representational point of view (vividness).	$N = 257$[c]	✓	✓ 3D vs. VR (HTC Vive)	✓ (Single shelf)		Mueslis		✓	• Immersion does not affect the users' intention to reuse the shopping environment, because two paths cancel each other out: Highly immersive shopping environments positively influence a hedonic path through telepresence, but surprisingly, they negatively influence a utilitarian path through product diagnosticity.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Kang et al. (2020)	Stereoscopic displays of VR: the ability to visualize a product in the 3-dimensional world with the depth information, namely visual–spatial cues, that is visual inputs that guide people to construct the object's spatial relation.	$N = 169 + 49$		✓ 3D vs. VR (Quest 2)			Office furnitures	✓ (Graphics quality)	✓	• Interactivity and visual–spatial cues significantly enhance perceived informativeness and playfulness, with graphics quality being more critical for 2D displays than for 3D VR environments. • Informativeness and playfulness influence the purchase decision-making process: a playful interface may enhance consumers' preference for hedonic product benefits (e.g. a stylish and attractive design), whereas informativeness is a more important explanatory variable for subsequent purchase intentions.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Lombart et al. (2020)	Immersion: the experience of fidelity (e.g. the quality of the 3D graphics, the resolution of the screens used, and whether they wear a Head-Mounted Display or not) with which this virtual environment is created.	*N* = 192	✓	✓ Physical vs. 3D vs. VR (Rift DK2)	✓		Groceries		✓	• Perceptions of appearance and quality of VR stores (non-immersive and immersive) are similar to perceptions in a physical store. • The positive effect of price fairness on hedonism was significant for the physical and immersive VR store but not the non-immersive VR store. • Consumers tend to rely more on extrinsic cues (e.g. price) in the immersive VR store but intrinsic cues (e.g. appearance) in the physical store.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Meißner et al. (2020)	Telepresence: Transportation […] in the sense that users' consciousness is being transported to an alternative place, completely different from where they actually are, and they feel and act as if they were in a real place.	$N = 257$[c]	✓	✓ 3D vs. VR (HTC Vive)	✓ (Single shelf)		Mueslis			• Consumers in high (vs. low) immersive VR choose a larger variety of products and are less price-sensitive. • Choice satisfaction does not increase in high (vs. low) immersive VR.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Pfeiffer et al. (2020)	Immersion: the degree to which a VR systems' output is comparable to physical stimuli.	*N* = 29 *N* = 20	✓	✓ (Physical vs. 3D CAVE)	✓ (Single shelf)		Mueslis, Groceries			• Vector machines allow the correct classification of search motives with 80% accuracy in virtual reality and 85% accuracy in physical reality. • Eye movements allow shopping motives to be identified relatively early in the search process: our models achieve 70% prediction accuracy after only 15 seconds in virtual reality and 75% in physical reality. • This suggests that information search behavior in VR might be similar to the one used in physical reality.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Schnack et al. (2020)	Telepresence: a feeling of "being there" in the virtual environment; the extent to which a user accepts the virtual illusion of a real place.	$N = 153$		(HTC Vive)	✓		Groceries			• Participants invest search time to examine products and read product labeling, as indicated by the fact that handling times for fictional products were on average significantly longer than for well established brands • Participants' perceived need to acquire product information before purchasing a new product indicates that a level of perceived risk was associated with the decision, despite there being no actual physical or financial risk associated with the virtual purchase.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Schnack et al. (2021)	No definition provided.	$N = 113$		(HTC Vive)	✓	✓ (Staff)	Groceries		✓	• Shopper personality was not found to explain VR shopping behavior, which contradicts findings of existing research.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Schnack et al. (2021)	No definition provided.	$N = 71$	✓	✓ (HTC Vive: Walk vs. teleport)	✓	✓ (Staff)	Groceries			• Walking (vs. teleportation) had no effect on participants' engagement, excitement, or stress, neither at the aggregated level nor in individual shopping phases, basket size, amount spent, trip duration, private labels shares, the probability of purchasing unfamiliar products, product handling times, and the number of unplanned purchases. • Walking (vs. teleportation) had an impact on store movement patterns, with teleportation resulting in some sections being skipped.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Bigne and Maturana (2023)	Immersion: Refers to how users engage with a simulated reality based on its resolution, richness, and their interaction with the simulated environment.	$N = 202$	✓	✓ 2D vs. VR (Quest 2)			Vacation		✓	• VR (vs. a 2d e-commerce website) generates a higher sense of presence, which is driven by the higher level of immersion. • It was also observed that VR produced a greater attitude toward change, and that this factor depended more on the sense of presence generated by the VR, than on enjoyment.
Bin Kim and Jung Choo (2023)	Immersion: A VR system with different technical specifications, such as environment size, navigation tools, system requirements, responsiveness to user movement, and degree of perception toward the presented world.	$N = 60$	✓	✓ 2D vs. VR (Quest 2)	✓ (Branded)		Sports shoes	✓ (Realism)		• Immersive VR experience increases consumers' creative ability through an increased perceptual curiosity toward the VR store. • Consumer creativity is affected by perceptual curiosity, contrary to pleasure and psychological arousal.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
Branca et al. (2023)	No definition provided.	$N = 16$ $N = 167$ $N = 41$	✓	✓ Physical vs. VR (Quest 2)			Milk packages			• When it comes to actual behavior analysis, the results of three studies confirmed that consumers' evaluation of products in VR is consistent with those in real life.

(*Continued*)

Table 1. (Continued).

Study	Conceptualization of fidelity	Sample[a]	Lab Experiment[b]	Fidelity manipulation	Virtual store	Animated Avatars	Product/s	Moderator/s	Mediator/s	Main Findings
The present research	Metaverse fidelity: The degree of conformity between the visual quality and experience in the virtual reality to the same in the real-world.	*N* = 127	✓	✓ VR (Quest 2) vs. VR+ (HP Reverb)	✓ (Interactive)	✓ (Customers, Staff)	Groceries	✓ (Store visit goal, Gender)		• The results indicate that high (vs. low) metaverse fidelity decreases male (not female) customers' future store visit intentions, however, only in response to browsing (not shopping) in the virtual retail store. • These findings suggest metaverse fidelity to generate gender-specific responses that are also goal-specific, hence underscoring that contextual sensitivity might be a methodological barrier in metaverse studies.

Notes: [a]Denotes sample sizes in main studies, excluding pretests and pilot studies. [b]Denotes inclusion of (at least one) controlled laboratory experiment(s). [c]Studies are reported on the identical convenience sample. The literature presented originates from a Scopus title/abstract/keyword search on peer-reviewed articles published in the domains of "Psychology" and "Business, Management, and Accounting" in English (as of 13 October 2023). We restricted the articles to those that fulfilled the following text-search criteria: ("metaverse" OR "VR" OR "virtual reality") AND (service OR retail OR consumer OR customer OR manag* OR market*) AND shop* AND (fidelity OR visual* OR realism OR quality OR immers*). This search procedure resulted in a total of 47 articles that were screened for suitability. Articles based on quantitative empirical evidence employing VR devices focusing on the role of fidelity in shopping settings were selected for inclusion, resulting in a final sample of 14 articles as summarized above.

Method

The study is based on a metaverse retail store developed for the purpose of testing consumer behavior in virtual environments. The store represented a scaled-down version of a brick-and-mortar retail store, fully equipped with products, shelves and freezers, and populated with virtual avatars representing staff and customers. In a prior validation study, this store was found to generate comparable consumer responses to those typically exhibited during real-world shopping, thereby attesting to the external validity of this research environment (Jacobsen, Mossing Krogsgaard-Jensen, and Peschel 2022). Moreover, as suggested by several scholars (e.g. Lynch 1982; Sabri 2017; Winer 1999), the use of two distinct store visit scenarios, according to which participants were either instructed to shop for the products or, alternatively, to browse the store to 'get a good overview' of the products, should bolster the external validity of our findings (Borau et al. 2021; Loebnitz, Frank, and Otterbring 2022; Otterbring et al. 2023).

Participants

A total of 127 participants (age: M = 25.0, SD = 7.8, range: [18, 70]; 55.1% females), recruited through the behavior lab panel at a large university in Northern Europe, completed the study and were eligible for inclusion in this research. Participants were prescreened under the condition of speaking English, being at least 18 years old, and shopping for groceries at least occasionally. As evident from Table 1, the sample size lies above the median sample size of 113 participants across all prior relevant studies. Given our experimental design, this sample size has a statistical power greater than 90% to detect moderately sized main effects corresponding to d = 0.60, assuming the conventional alpha level of α = .05; in fact, this sample size and alpha set at α = .05 implies over 80% power to detect two-way crossover interactions whereby the simple slope effects correspond to effect sizes equivalent to $\pm$ d = 0.50 (Sommet et al. 2023). Considering that effect sizes of d = 0.50–0.60 are the typical ones examined in marketing and consumer behavior (Eisend 2015), the study is well-powered for detecting such medium-sized main and interaction effects.

Design and stimuli

The study was a controlled laboratory experiment with four conditions in a 2 (fidelity: high vs. low) $\times$ 2 (goal: shopping vs. browsing) between-subjects design, with participant gender (male vs. female) as an additional measured between-subjects factor.

Metaverse fidelity was manipulated by means of the VR headset through which participants experienced the virtual store. In the high fidelity condition, participants used the HP Reverb G2 Omnicept Edition, a tethered VR headset, featuring a high resolution (2160 x 2160 per eye), large field of view (114 degrees), and professional-grade computer graphics. In the low fidelity condition, participants used the Oculus Quest 2, a portable VR headset, featuring a lower display resolution (1832 x 1920 per eye), smaller field of view (89 degrees), and battery-powered, mobile-graphic processing

power. The difference in fidelity between the two conditions can be experienced through a side-by-side comparison of the headsets, as illustrated in the visual representation in Figure 2.

The metaverse store was designed to be as naturalistic as possible, and featured the layout of a small brick-and-mortar retail store, fully equipped with shelves, freezers (for a

Figure 2. Illustrations of high (red) vs. low (blue) fidelity of the virtual store. Notes. These illustrations are based on 3D pre-renderings taken from the VR development environment and do not reflect the actual experienced fidelity of the metaverse retail store when viewed on the VR headset. This is due to various factors including lights and shades, visual depth, and varying refresh rates thereby adding to the limitation of capturing a true visual representation. The differences in graphic resolution have been exaggerated for illustrative purposes. The dotted lines indicate the field of view of the respective fidelity condition.

detailed floor plan, see Figure 3). The store was equipped with various grocery products from different categories (e.g. foods, drinks, snacks, sweets, dairy, meat, alcohol) and populated with a total of five non-player characters (cf. avatars), animated with a looped movement to enhance overall realism. Participants navigated through the store using teleportation.

Procedure

At the beginning of each session, participants were given a consent form and one of two randomized scenarios, which instructed them to shop (vs. browse) in the store in preparation of a romantic surprise dinner for their partner, for which there were three missing ingredients: a package of pasta, a jar of pizza sauce, and a bar of dark chocolate. Moreover, participants were faced with a financial restraint (about 8 EUR) to purchase all three items (for the actual scenarios, see Table A1 in Appendix A).

After acknowledging that the task based on the scenario was understood, the researcher introduced participants to the VR controller to ensure that they (from beginner to advanced user) had an equal understanding of the placement of the thumbstick, buttons, and triggers, prior to obscuring their vision with the headset. Each participant had assistance when putting the device on to ensure a consistent fit on their face. If participants used glasses, they were instructed based on their own comfort level to make a choice as to what gave them the clearest level of detail. No participant chose to take their glasses on/off once committing to their initial decision.

Prior to the experimental task, each participant went through a non-timed, interactive tutorial with a series of guided steps to familiarize themselves with the basic controls, such as to teleport within the environment, pick up and evaluate multiple items, and access and use the virtual shopping basket, so that participants became familiar with the experimental task of shopping in the metaverse retail store (Meißner et al. 2020; Roberts

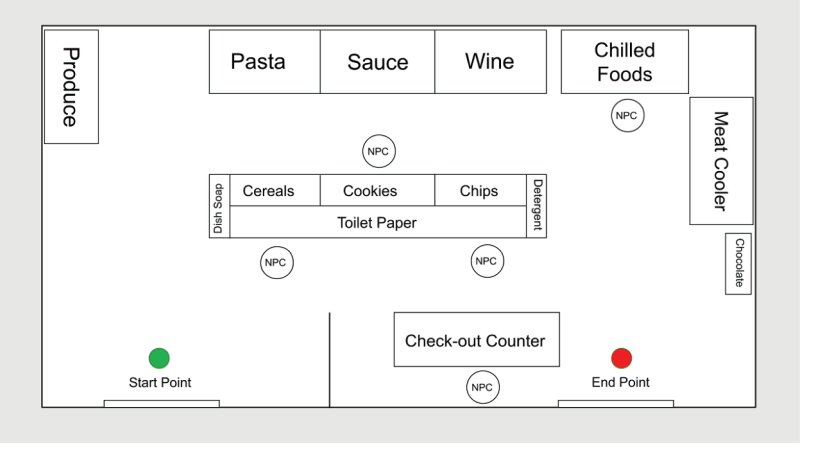

Figure 3. Floorplan of virtual store.

and Grassi 2021). Only proper execution of these three functions allowed participants to end the tutorial.

Following completion, and prior to 'entering' the virtual store, participants were asked to restate the task that they had been given. Most participants (84.3%), understood their task correctly. In the remaining 15.7% of cases, instructions were repeated to ensure everyone understood their task. Next, participants were asked to complete their task and when finished, navigate to the virtual store's exit and leave without paying. The duration of the experiment was approximately 30 min, of which participants spent about 15 min in the metaverse retail store, thus effectively corresponding to two full working weeks of data collection.

Measures

After completion of the VR experience, participants sat down at a computer where they answered a questionnaire reflecting on their experience. This questionnaire included a 3-item scale on participants' future store visit (repatronage) intentions (e.g. 'I intend to shop at this store in the future,' rated on a scale from 1 = *strongly disagree* to 7 = *strongly agree*; adapted from Maxham and Netemeyer 2002; Cronbach's α = .91). Participants also answered demographic questions, such as their age and gender, as well as a set of questions related to a different research project. Before analysis, data from the researchers' session notes and participants' post-experience questionnaires underwent a process of merging, cleaning to remove missing values, restructuring for better readability, and preparation to obtain composite indices.

Results

To test our conceptual model, which suggests that the influence of metaverse fidelity on customers' future store visit intentions is contingent on their gender (as per our main hypothesis), with this predicted two-way interaction potentially further moderated by customers' specific store visit goal (as per our exploratory test), we conducted a moderated moderation analysis using PROCESS Model 3 (Hayes, 2018). In this analysis, metaverse fidelity was the predictor (high = 1, low = 0), participants' gender (female = 1, male = 0) and store visit goal (shopping = 1, browsing = 0) were the moderators, and future store visit intentions was the outcome variable.

The results of this analysis showed that the effect of high (vs. low) metaverse fidelity was significant and negative ($b = -1.47$, SE = .59; $t = -2.47$, $p = .015$, 95% CI: [−2.64, −0.30]), with future store visit intentions in fact being lower under conditions of high (vs. low) fidelity. The effects of participants' gender ($b = -0.92$, SE = .56; $t = -1.67$, $p = .10$, 95% CI: [−2.02, 0.18]) and store visit goal ($b = -0.81$, SE = .56; $t = -1.45$, $p = .149$, 95% CI: [−1.91, 0.29]) were non-significant. Importantly, and in line with **H1**, the predicted two-way interaction between fidelity and consumer gender was statistically significant, such that high (vs. low) metaverse fidelity had a more pronounced positive effect for female (vs. male) participants ($b = 2.19$, SE = .78; $t = 2.81$, $p = .006$, 95% CI: [0.64, 3.73]). Although unanticipated, a similar positive effect of metaverse fidelity in the shopping (vs. browsing) goal-orientation condition also emerged ($b = 1.58$, SE = .82; $t = 1.92$, $p = .057$, 95% CI: [−0.05, 3.20]), albeit slightly above

conventional levels of statistical significance. Consumer gender did not interact with the store visit goal (b = 0.61, SE = .77, t = 0.80, p = .428, 95% CI: [−0.91, 2.13]).

Interestingly, as per our exploratory test, the analysis revealed a significant three-way interaction (b = −2.23, SE = 1.10; t = −2.02, p = .046, 95% CI: [−4.41, −0.04]). The conditional effect of high (vs. low) fidelity on customers' future store visit intentions was significant and negative for male customers (b = −1.47, SE = .59, 95% CI: [−2.64, −0.30]) and directionally positive for female customers (b = 0.72, SE = .51, 95% CI: [−0.29, 1.72]) in the browsing condition. The same metaverse fidelity × gender moderation was not found in the shopping condition (b_{female} = 0.07, SE = .53, 95% CI: [−0.99, 1.13]; b_{male} = 0.11, SE = .57, 95% CI: [−1.02, 1.23]). This interaction of metaverse fidelity × gender for the browsing but not the shopping condition is also evident from the respective means of the eight conditions shown in Figure 4.

Additional moderated moderation analyses that controlled for participants' age and prior experience with VR showed no influence of these additional factors, and did not change the nature or significance of the results reported above.

Discussion

In the current research, we examined the impact of metaverse fidelity on customers' future store visit intentions by exposing customers to high (vs. low) metaverse fidelity for two different store visit goals (browsing vs. shopping) in an experimental setting. Consistent with **H1**, our findings reveal that consumer gender moderates the effect of fidelity, with high (vs. low) fidelity having a particularly pronounced positive effect on female (vs. male) customers' store visit intentions. Further, our exploratory test demonstrates that this gender-specific pattern, in turn, is contingent on customers' precise store visit goal, such that the metaverse

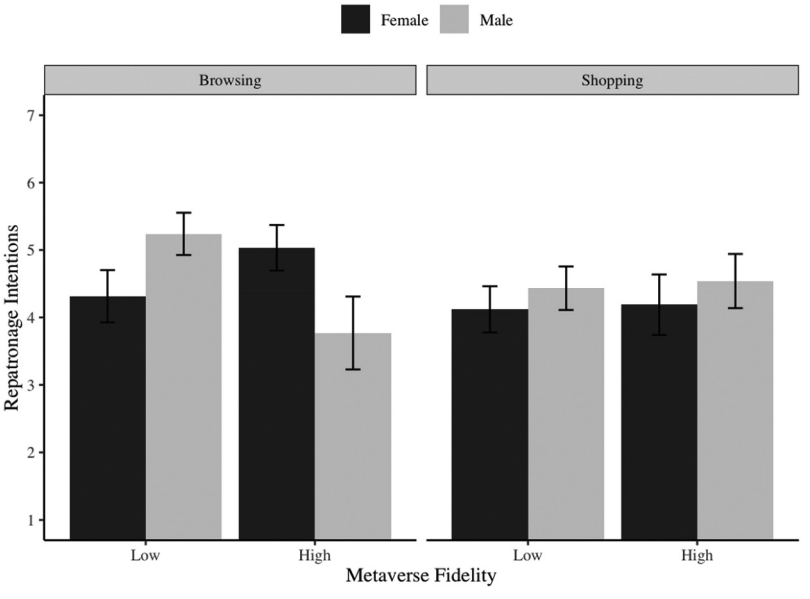

Figure 4. Ratings for participants' future store visit (repatronage) intentions by metaverse fidelity × participant's gender × store visit goal. Error bars indicate standard errors of the means.

fidelity × consumer gender pattern mainly applies to customers browsing a retail store, but not necessarily when their goal is focused on shopping. These findings indicate that customers' responses to metaverse fidelity might be contingent on their gender and the specific goals they have when entering a store (e.g. shopping vs. browsing).

Theoretical contribution

The findings reported herein contribute to a growing stream of conceptual work on customer responses to retailing in the metaverse (Giang Barrera and Shah 2023; Grewal, Roggeveen, and Nordfält 2017; Sina and Wu 2023) by providing empirical evidence that metaverse fidelity may influence retailers' performance through its effects on customers' future store visit intentions. This complexity seems contingent on both the customers' gender and their goals when visiting a virtual retail store. We do not find metaverse fidelity to directly lead to more positive customer responses as anticipated based on previous research from adjacent domains (Petit, Javornik, and Velasco 2022; Wang et al. 2022). If anything, our results reveal the reverse.

Collectively, this work provides a more nuanced view of metaverse fidelity effects by accounting for gender differences and common goals that customers have when visiting stores.

Specifically, the present study documents a more positive effect of high (vs. low) metaverse fidelity for female customers but a significant negative effect of high fidelity for male customers with respect to their future store visit intentions after browsing the metaverse store. Although traditional gender roles are changing, we follow McKay-Nesbitt et al. (2013) in assuming gender differences in information processing based on regulatory focus. Based on their research, we assumed female participants to be more prevention-focused and male participants to be more promotion-focused in their information-processing to obtain their shopping or browsing goal.

Browsing and shopping goals are inherently different in terms of information-processing requirements (Moe 2003; Putsis and Srinivasan 1994; Urbany, Dickson, and Wilkie 1989). Consumers process more information, at least superficially, during browsing (vs. shopping). While consumers search for in-depth information to solve current problems in shopping tasks, they gather more information for later usage in browsing tasks. Building on previous research on regulatory focus across genders, we explored the possibility that a more pronounced gender difference would emerge in the browsing task compared to the shopping task across metaverse fidelity conditions. The degree of information needed to fulfill the shopping task was limited and easily obtainable across fidelity conditions, which does not allow for greater variation in terms of prevention or promotion focus. However, the browsing task can be considered more abstract, with more degrees of freedom on which information to focus on and how. Female customers, with their higher tendency for prevention focus, might prefer to obtain as much information as possible, which should be possible at higher ease in the high metaverse fidelity condition. Male customers, however, with their tendency for promotion focus, may want to accomplish the browsing goal without extra information they deem irrelevant and might therefore prefer the low metaverse fidelity condition. Our gender-specific findings align with the results from Huang and Klippel (2020), who suggested that high fidelity is likely to promote detail orientation while low fidelity promotes generalization. Hence, prevention-focused females value high fidelity due to their more detail-oriented information

processing style, particularly in the browsing condition, relative to promotion-focused males, thus explaining why female customers report more favorable future store visit intentions of the metaverse retail store under such settings.

Practical implications

For the future of metaverse retailing, the findings of the present research offer novel insights that help companies allocate resources in the development and design of future VR headset technologies and experiences in the realm of high fidelity experiences (Laurell et al. 2019). An implication of our findings would be that retailers designing metaverse shopping experiences may want to consider increasing (reducing) the level of realism in the virtual environment designed for female (male) customers with a browsing goal (Vrechopoulos, Apostolou, and Koutsiouris 2009). This could lead to a more positive browsing experience and potentially increase customers' likelihood of future store visits. Moreover, the reduction of metaverse fidelity could have immediate application with a larger male customer base and virtual showrooming. The reduced metaverse fidelity requirements would create greater integration opportunities due to a wider range of headsets already on the market. While the current metaverse customer base skews male, prominent brands like L'Oréal or Prada are aggressively entering the market with products targeted primarily at female consumers (FWO 2022; L'Oréal, 2022). This suggests that a higher level of metaverse fidelity may hold greater significance for female segments. Given that females are more prone to browsing than their male counterparts (Jarboe and McDaniel 1987; Xia 2010), high fidelity will gain increasing relevance in meeting their preferences.

We did not find any differences in future repatronage intentions when the store visit goal was focused on shopping. This null-finding could be due to the shopping setting used, which can be conceptualized as a low-involvement decision-making scenario related to buying groceries. Managers should remain cautious before ruling out the importance of metaverse fidelity for customers' metaverse retail shopping experiences in other shopping settings characterized by higher involvement levels. This is particularly relevant when customers process more information to make their purchase decisions (e.g. retail of white goods or consumer electronics) compared to when shopping for groceries, which is typically very habitualized (Hoyer 1984; Machín et al. 2020).

Limitations and future research

The current research tested for effects of metaverse fidelity on customer responses using two different headsets and two distinct store visit scenarios: shopping and browsing. This experimental setup provided preliminary evidence on the importance of metaverse fidelity in specific contexts (i.e. when browsing). However, our examination only constitutes a first step and more research is needed as newly released devices, such as Apple's Vision Pro or Meta's Quest Pro, continue to push the boundaries of fidelity, potentially leading to further increases or, alternatively, the saturation of its effects on customer responses to immersive metaverse retail experiences.

A critic might argue that we did not provide empirical evidence for the effectiveness of our manipulated factors, given our decision to abstain from including formal manipulation checks. However, it should be noted that many scholars actively advise against using

manipulation checks when the factors to be manipulated are objectively different (e.g. Nazifi et al. 2021; O'Keefe 2003; Perdue and Summers 1986), which was the case both with respect to our fidelity manipulation and our store visit scenarios. Indeed, our fidelity factor was not primarily based on participants' subjective perceptions but rather on the objective technical specifications of the devices used. Similarly, our second manipulated factor (store visit goal) was also distinctly different across conditions in objective content and hence does not need to be verified by a manipulation check, although participants were asked to verify that they had correctly understood their assigned tasks before proceeding (the vast majority did), which could be interpreted as a successful manipulation check. While we acknowledge that it may be worthwhile to add more formal manipulation checks when the focus is on consumers' *subjective perceptions* on the manipulated factors rather than objective differences within the factors themselves, the inclusion of manipulation checks does not necessarily prove the effectiveness of a given manipulation (Gruijters 2022; Hauser, Ellsworth, and Gonzalez 2018; Sigall and Mills 1998). For example, presenting a manipulation check prior to the focal dependent variable may generate expectancy and demand effects, with participants starting to guess the research hypothesis, thereby contaminating the research design and inadvertently *manipulating* the corresponding results (Fayant et al. 2017; Kühnen 2010). Additionally, even a seemingly failed manipulation check that was included after, as opposed to before, the focal dependent variable does not automatically imply that the manipulation failed; it might just indicate that it was potent enough to influence participants' responses on the dependent variable but that its effectiveness did not survive all the way to the end of the experimental session, where the manipulation check item appeared to study participants (Chester and Lasko 2021; Ejelöv and Luke 2020). Accordingly, and despite their many merits, manipulation checks do not always guarantee that a given study is more rigorously conducted; in fact, many times, the opposite applies.

For pragmatic reasons, given sample size constraints, we did not focus on the broader spectrum of gender identities, despite the relevance of doing so in marketing, retailing, and consumer research (Åkestam et al. 2021; Liljedal, Berg, and Dahlen 2020). Instead, we relied on the common binary male/female categorization. This decision can be justified by the proportion of consumers who report identifying with a gender different from their sex registered at birth. For instance, in a large-sampled investigation of people living in England and Wales in March 2021 spanning almost 50 million individuals, 99.43% of those who replied to the question, 'Is the gender you identify with the same as your sex registered at birth?' answered with an affirmative 'yes,' whereas less than 1% of those who replied (0.57%) answered 'no' (Office for National Statistics 2023). That said, studies with (considerably) larger and more diverse samples could still examine a wider range of gender identities in relation to our addressed phenomena (cf. Nyhus et al. 2023).

Although the current research employed a laboratory investigation of customer responses when visiting a metaverse retail store, our findings are based on self-report. Future research should include behavior data that can be obtained from modern devices, such as head- and eye-tracking, heart rate measures, and logged interactions, to support and extend the present findings with behavioral responses. In addition, because laboratory experiments have high internal validity but typically lower external validity (Otterbring 2021), future studies should be carried out in the field at customers' homes

using mobile headsets to further boost realism and test the replicability and generalizability of the current findings in more ecologically valid conditions.

Furthermore, future research is needed to study customer shopping in different environments and with a wider variety of products. As suggested earlier, shopping motives may be vastly different when customers are searching for their next kitchen, sofa, or maybe even car, compared to when buying a package of pasta. Indeed, the interpurchase cycle of various products has been shown to influence customers' purchase decisions, such that customers are typically more risk averse when purchasing products with a longer (vs. shorter) interpurchase cycle (e.g. a package of cereals instead of a piece of candy), as they typically have to live longer with the consequences of making a 'bad' purchase decision for such products (Inman, Winer, and Ferraro 2009; Otterbring et al. 2014).

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix A

Table A1. Scenarios used for buying and browning tasks.

Scenario: Buying

Imagine you want to surprise your partner with dinner. Since spending your holiday last summer in Italy, you have the idea to reminisce about the time together with an Italian menu.

You have put together a small menu with a variation of Italian specialties. As a starter, you will prepare a tasty pasta salad, followed by a delicious pizza. To finish, you are to enjoy a bar of dark chocolate.

You do not have all the ingredients for dinner yet and you only have **60 DKK** in your budget.

You have to go to a store where you can buy these missing ingredients within your budget constraint.

Therefore, you go to a store and **buy a package of pasta, a jar of pizza sauce, and a bar of dark chocolate**.

Your task is to **choose one product** from the **pasta, pizza sauce, and chocolate category** and you should **not spend more than 60 DKK**.

Scenario: Browsing

Imagine you want to surprise your partner with dinner. Since spending your holiday last summer in Italy, you have the idea to reminisce about the time together with an Italian menu.

You have put together a small menu with a variation of Italian specialties. As a starter, you will prepare a tasty pasta salad, followed by a delicious pizza. To finish, you are to enjoy a bar of dark chocolate.

You do not have all the ingredients for dinner yet and you only have **60 DKK** in your budget. You are not sure at which store you can get these missing ingredients within your budget constraint.

Therefore, you visit a store and just browse for a **package of pasta, a jar of pizza sauce, and a bar of dark chocolate**.

Your task is to get a **good overview** of the available **pasta, pizza sauce, and chocolate products** in this store, but you will **not buy anything today**.

Table A2. Virtual reality headsets used for manipulation of high and low metaverse fidelity.

	Low Fidelity	High Fidelity
Device name	Meta (former: Oculus) Quest 2	HP Reverb G2 Omnicept Edition
Resolution	1832x1920 per eye	2160 x 2160 pixels per eye
Refresh rate	120 Hz (limited to 90Hz)	90 Hz
Field of view	89 degrees	~114 degrees, Fresnel-Aspherical
Eye adjustments	–	64mm ± 4mm by hardware slider
Display panel	Fast-switch LCD	Dual LCD 2.89'' diagonal with Pulse Backlight technology
Processor	Qualcomm® Snapdragon™ XR2 Platform	NVIDIA GeForce GTX1080 paired with an Intel i7, 4.20 GHz CPU Processor and 16 GB RAM
Input/Controls	Two Oculus Touch controllers with haptic feedback enabled	Two HP Reverb controllers with haptic feedback enabled
Tracking	Oculus Insight inside-out tracking	2 front-facing cameras and 2 side-facing cameras, plus eye tracking with pupillometry
Audio	Integrated positional audio	Integrated positional audio
Connection	Wireless	Combined DisplayPort™ 1.3, USB 3.0 type C, power adapter cable
Battery Life	4–5 hours	–
Weight	500g	727g